Definition of Progressive Collapse

Brian Crowder, P.E.

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So what is “Progressive Collapse”

- **Several terms used to address issues revolving around progressive collapse**
- **Definitions vary over time and with nation**
- **Often term is debated with respect to specific historical events**
  - **Was collapse of the World Trade Center towers progressive collapse?**
  - **Was the collapse of Oklahoma City Federal Building progressive collapse?**

Review of Definitions – British Standards

- **Doesn't use word *progressive collapse*, instead uses *disproportionate collapse***
- **"The building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause"**
- ***Local collapse* is limited to 15% of floor or roof area or 1000 ft^2 whichever is less at the relevant level and at one immediately adjacent level (above or below)**

Review of Definitions - Eurocode / CEN1

- **A structure shall be designed and executed in such a way that it will not damaged by events like fire, explosion, impact, or consequences of human error, to an extent disproportionate to the original cause**
- **Provides choices to meet requirement including**
  - **Elimination or reduction of hazards**
  - **Designing for the loss of an individual element or a limited part of the structure (localized damage)**
  - **Tying the structure together**
  - **etc**

Review of Definitions – NBC of Canada

- **1975 – "*Progressive collapse* is the phenomenon in which the spread of an initial local failure from element to element eventually results in the collapse of a whole building or *disproportionately* large parts of it"**
- **1977 – similar to 1975 with limits on amount of local collapse**
- **1990 – "*Structural integrity* is defined as the ability of the structure to a absorb local failure without widespread collapse"**

Review of Definitions – ANSI A58.1 1972

- **First U.S. consensus document to add discussion of progressive collapse**
- **Content: Progressive Collapse. Buildings and structural systems shall provide such structural integrity that the hazards associated with progressive collapse, such as that due to local failure caused by severe overloads or abnormal loads not specifically covered here in, are reduced to a level consistent with good engineering practice.**

Review of Definitions – ANSI A58. 1- 1982

- **Changed to: "… buildings and structural systems shall possess general structural integrity, which is the quality of being able to sustain local damage with the structure as a whole remaining stable and not being damaged to an extent disproportionate to the original damage.**
- **Really defines "structural integrity"**
- **Appendix provided concepts of indirect and direct design for structural integrity**
- **ANSI A58.1 became ASCE7 and definitions remain similar**

Review of Definitions – ASCE 7-2002

- **General Structural Integrity**
  - **Buildings and other structures shall be designed to sustain local damage with the structural system as a whole remaining stable and not being damaged to an extent disproportionate to the original local damage. This shall be achieved through an arrangement of the structural elements that provides stability to the entire structural system by transferring loads from any locally damaged region to adjacent regions capable of resisting those loads without collapse. This shall be accomplished by providing sufficient continuity, redundancy, or energy-dissipating capacity (ductility), or a combination thereof, in the members of the structure."**

Review of Definitions – U.S. National Codes

- **IBC, UBC, SBC – No references**
- **BOCA – reference to ASCE 7 structural integrity provisions**
  - **This is insufficient for a design procedure**
- **ACI 318 – since 1989 structural concrete material code has included structural integrity**
  - **"..It is the intent of this section to improve the redundancy and ductility in structures so that in the event of damage to a major supporting element or an abnormal loading event, the resulting damage may be confined to a relatively small area and the structure will have a better chance to maintain overall stability."**
- **AISC, AFPA/AWC – No references**

Common Features of Definitions

- **Initial unspecified local failure or damage**
  - **Initial damage caused by abnormal or accidental event that is unknown to the designer**
- **Resulting damage/collapse is not to be disproportionate to cause**
- **Some definitions provide allowable extent of damage in order to still be considered acceptable or "local"**

DoD Definition – 1999 (Errata)

- **Requirement driven through Antiterrorism criteria that seeks to reduce the risk of mass casualties**
- **Although approach is not threat specific, event causing initial damage was envisioned to be explosive attack**
- **Definition used in interim design guidance (5 March 2001) based on ASCE 7 definition**

UFC 4-010-01 – 8 October 2003

- **"Progressive collapse. A chain reaction failure of building members to an extent disproportionate to the original localized damage. Such damage may result in upper floors of a building collapsing onto lower floors"**
- **Text of design requirement relies heavily on ASCE 7 definition**
- **Relies on interim technical guidance to establish acceptable limits of "local" damage**

UFC 4-023-03, Current DoD Definition

- **Defines progressive collapse consistently with commentary of ASCE7-02**
- **PC = spread of an initial local failure from element to element, eventually resulting in the collapse of an entire structure or a disproportionately large part of it**
- **Not intent to resist general collapse caused by severe abnormal loads, i.e. doesn't prevent local damage**
- **Intent to limit effects of local collapse and to prevent or minimize progressive collapse**

UFC 4-023-03, continued

- **Definition in new UFC is consistent with current U.S. standards – ASCE 7-02**
- **Clarification provided on intent**
  - **Initiating event is undefined**
  - **Hardening is not the intent**
  - **Goal is to prevent or minimize progressive collapse by ensuring redundancy and continuity in structural system**
- **Provides limits of local damage following initiating event**

Questions……..